

A totally pre-cast substructure allows a bridge capable of spanning more than 115 ft. to be completed in a matter of days.



NEW HAMPSHIRE New Hampshire Innovates with First “Fast Track”

SMALL TOWN, BIG PAYOFF FROM ACCELERATED BRIDGE CONSTRUCTION

With just under 5,500 residents, Epping, New Hampshire is not the first place that comes to mind when considering cutting edge highway practices and technology. Major traffic jams are pretty rare.

But where most people see a quiet, little town, the New Hampshire Department of Transportation (NHDOT) saw an opportunity to try something it had never tried before: a fast-track approach to bridge design. In the end, the Mill Street Bridge project not only exceeded customer expectations, it mirrored the objectives of safer, better highways and faster, more cost-effective delivery that form the foundation of the Federal Highway Administration's (FHWA) Highways for LIFE program.

The Mill Street Bridge

The bridge in question was the Mill Street Bridge, which spans New Hampshire's Lamprey River. The 120-foot long existing crossing consisted of two 30-foot long simple span bridges separated by a 60-foot long center pier/causeway. The bridges were in poor condition thanks to bitter New England winters and a susceptibility to major flooding every spring. Design issues were challenging and fairly typical of New Hampshire's bridge projects: the south abutment was founded on a shallow, sloping ledge and the north abutment was founded on granular material. Issues with water control added complexity to the construction of new foundations.

Traffic volume on the twin spans was light at approximately 500 vehicles per day, so closing the bridges for an extended period of time did not present a major disruption. However, engineers with NHDOT wanted to test an accelerated construction approach on a State project, and chose to start small to prove the process.

According to Pete Stamnas, Senior Project Engineer with the NHDOT Bureau of Bridge Design, the Mill Street Bridge was the ideal place to experiment. “We wanted to start slow and understand how the fast-track approach works before using it in a more challenging site. At the Mill Street Bridge, we saw an opportunity to tackle a low risk project on a road that is not heavily traveled and is easy to detour around.”

The Meaning of “Fast-Track”

The goal of fast-track methods is to achieve a safe, high-performance result while completing construction as quickly as possible using simple and versatile solutions – typical of the goals Highways for LIFE encourages agencies to target when tackling construction projects. One of the most innovative solutions used on the Mill Street Bridge was a totally precast substructure.

Stamnas explained, “The key to rapid construction is the substructure that emulates cast-in-place concrete using precast elements. This allows for minimal traffic disruption, improves work zone safety, improves constructability, limits the footprint – especially if temporary bridges can be avoided – and encourages cost savings.” As part of the fast-track approach, FHWA’s Innovative Bridge Research and Construction Program provided a portion of the funding for the bridge replacement.

A Collaborative Approach

Part of the project’s success hinged on assembling a team knowledgeable enough to develop a comprehensive plan before moving a shovelful of earth. When the idea for the project was born, NHDOT presented its team with two challenges: (1) limit the road closure to 30 days, and (2) assemble the bridge in less than 14 days.

A basic design was developed and advertised, but bids for the original concept were in excess of the budget, necessitating some changes and re-advertisement. The new concept eliminated the maximum road closure duration (1) but maintained the 14-day bridge assembly requirement (2). The project was re-advertised. The low bid was presented by R. M. Piper, Inc. and precaster J. P. Carrara and Sons, Inc. Stamnas recalled, “Part of what made this project such a success was the amount of industry participation and collaboration between the NHDOT, the contractor, and the precaster.”

In the end, the team surpassed all expectations. A bridge that normally would have taken three months to build was in place in an astonishing eight days.

Precast Substructure: Less Congestion and Faster Completion

Most bridges in New Hampshire are built using cast-in-place substructures. While the method is a reliable and accepted choice, it is anything but fast. When working with a cast-in-place substructure, time is a dominant factor: it takes time to build falsework, time to tie reinforcement, and time for the concrete to cure in each piece of the foundation, all of which ultimately

translates into extended time to complete the project. Motorists in Epping may not have experienced major inconveniences from a lengthy construction process, but when applied elsewhere in the region, the impact of cast-in-place substructures could be crippling.

By using a precast substructure, an extended time factor on the Mill Street Bridge was all but eliminated. Much of the work on the bridge was done well ahead of placement, limiting the amount of time the structure was actually under construction. Pieces of the precast substructure were simply assembled upon arrival at the construction site.

The integrity of the resulting bridge was also enhanced by the process. Precast concrete deployed on the Mill Street Bridge used technology that adds additional joints into the structure. Each piece is connected in such a way that the full structure works in unison to support the bridge. Similar connector technology has been used in Japan for a number of years with great success. It is also found in air traffic control towers built for the Federal Aviation Administration and elsewhere in the United States building industry.

The New Mill Street Bridge

Crews spent several weeks removing the existing bridge and preparing the site for a new structure. Then, in just eight days, the Mill Street Bridge was transformed into a state-of-the-art crossing.

The engineering details of this modest structure are impressive. Epping's new bridge features a 115-foot long adjacent box beam superstructure with transverse post-tensioning to span the river. The typical span range of the 3'-0" deep superstructure was extended with the use of High Performance Concrete (HPC) and 3/5" diameter strand. Full depth shear keys and two rows of 1/2" diameter strand, used as post-tensioning at six locations along the beam, are detailed to complete the connection between the units. The riding surface is comprised of waterproofing membrane and a bituminous pavement overlay. The superstructure is supported by full height, cantilevered, precast concrete abutments founded on precast concrete spread footings.

Residents of Epping are pleased with their new bridge. Town Administrator Stephen R. Fournier praised the project and its impact on the town upon its completion, saying, "The Mill Street Bridge project was a well-planned and well-executed project. The bridge is located in the downtown section of Epping. While you would expect a large project such as removing and replacing a bridge in the center of town would be disruptive for months, this project took only a few weeks and had minimal disruptions to the surrounding area. I heard no complaints during the construction process, and have heard numerous compliments on its design and the aesthetics of the bridge."

What Price Innovation?

NHDOT officials acknowledge that new technology and the application of new concepts can be more expensive in the short term than conventional methods. Estimates vary, but Stamnas guesses that the various components of accelerated construction raised the total project cost by anywhere from

10% -15% after accounting for money saved by eliminating the need for a temporary bridge. “If you compare just the price of a cast-in-place substructure versus a precast substructure, the increased cost was more than double,” he notes.

Relative savings, however, are worth noting. NHDOT is confident that, as the technology becomes more commonplace and as contractors and precasters become more familiar with its applications, costs will be reduced. Add to those expected efficiencies the time and expense saved by the roadway user who can avoid daily traffic backups caused by a lengthy construction project. Finally, one must consider a reduction in the most costly factor of all: work zone accidents, the risks of which are substantially mitigated when workers spend less time at work on the construction site.



Components of the new Mill Street Bridge arrived onsite ready for assembly thanks to careful collaboration and preplanning by the NHDOT, contractor R.M. Piper, Inc. and precaster J. P. Carrera & Sons, Inc.

Award Winning Approach

In the end, the Mill Street Bridge experiment was one that garnered accolades not only from Town residents but also from design experts.

The bridge won two awards from the Precast/Prestressed Concrete Institute (PCI) 2005 Design Awards Program – one for “Best Bridge with Spans Between 65 and 135 ft (20 and 41 m)” and the other for “Best All-Precast Solution.”

In bestowing the awards, the jury commented, “The most impressive feature of this bridge is that by making the substructure totally precast, the construction schedule of this project was significantly accelerated. The use of multiple precast elements, in particular spread footings, for the substructure

is commendable. As contractors and precasters become more familiar with this construction method, they will be able to apply the technique to a broad range of bridges, especially in rural areas.”

Lessons Learned

NHDOT knew there had to be a better way to build bridges and the Mill Street Bridge seemed like the perfect opportunity to try a ground-breaking approach. Thanks to a collaborative effort between NHDOT, The University of New Hampshire, PCI Northeast Region Technical Committee, the contractor and the precaster, residents of the small Town of Epping, New Hampshire received an attractive, state-of-the-art crossing with minimal disruption to traffic and businesses.

Along the way, the NHDOT learned several lessons. One technique that worked particularly well was detailing the masonry with the reinforcing shown only in sections. During a March, 2005 Structural Engineers of New Hampshire meeting, Stamnas said, “This allowed the contractor to choose the element sizes appropriate to their assembly approach, which was then submitted on plans stamped by one engineer for approval.”

Stamnas also cited things that could be improved: “The 1inch gaps in the footing/stem key were too small. Cork joints did not work because they did not allow for fit up tolerances. The stem shear was eliminated and the gap increased to 1 1/2 inches, then filled with closed cell material.” In addition, a minimum 2 feet between footing grouted splice joints and stem grouted splice joints was recommended.

Construction access is also something NHDOT recommends considering. Precast substructure elements easily weigh 30 tons and require plenty of room at the construction site. Transportation of precast elements should be planned carefully. Both the width and weight of the components must be examined to avoid additional transportation costs.

Finally, NHDOT recommends standardizing the size of precast and detailing components so that each can be fabricated using simple flat-slab construction, which curbs costs.

Most importantly, NHDOT learned that the use of accelerated construction techniques, in conjunction with high performance precast concrete, can cut construction-related traffic delays, boost work zone safety, and extend the long-term durability of bridges. NHDOT already plans to use lessons learned on the Mill Street Bridge on other construction projects. Team leaders can now say with confidence that if a bridge on a busier stretch of road needs to be repaired in a short amount of time, they have the tools and experience to tackle the job.



Replacement of the scenic Mill Street Bridge was completed in just eight days thanks to an innovative design featuring precast substructures, the first bridge in NH to utilize these methods.